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(54) Optimized management of K-byte information in telecommunication frames

(57) A SONET/SDH frame providing for an optimized management of K1 and K2 bytes of protection protocol and providing for the management of a number of nodes higher than sixteen, which is the highest number which is provided for at the present time. In practice, the bits (a_{K01}-a_{K08}) of a third byte K0 of Multiplex Section OverHead (MSOH) are used in such a way that at least one of them (a_{K05}, a_{K06}; a_{K03}, a_{K04}, a_{K05}) represents a Source Node IDentification Extension bit, at least one of them (a_{K07}, a_{K08}; a_{K06}, a_{K07}, a_{K08}) represents a Destination Node IDentification Extension bit and at least one bit (a_{K01}, a_{K02}, a_{K03}, a_{K04}; a_{K01}, a_{K02}) of those remaining indicates a change of the information in said first, second or third bytes (K1, K2, K0). In this way, the nodes which can be managed can be even 128 and the switching rate could be highly increased.

Byte K0							
TOGGLE: Change of Information		IDSNE: Source Node IDentification Estension			IDDNE: Destination Node IDentification Estension		
bit a_{K01}	bit a_{K02}	bit a_{K03}	bit a_{K04}	bit a_{K05}	bit a_{K06}	bit a_{K07}	bit a_{K08}

Fig. 2

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Descripti n

[0001] Th present invention concerns th field of synchronous telecommunication networks such as SDH or SONET telecommunication networks and in particular it concerns protection architectures of SDH/SONET networks. Still more in particular, it concerns the optimization of information of the K-bytes.

[0002] As far as for example SDH frames are concerned, it is known from the ITU-T *Recommendation* G. 707 that they are formed by structures which are nested at several synchronous multiplex layers whose basic components are called Synchronous Transport Modules level N (STM-N, N=1, ...) indicating the bit rate (for instance, STM-1 155 Mb/s, STM-16 2488 Mb/s). Each STM-N module comprises a header portion termed Section Overhead (SOH), containing management and synchronization auxiliary information, and a subsequent portion termed Information Payload containing the informative part.

[0003] The information of the SOH section is classified into Regeneration Section Overhead (RSOH) and Multiplex Section Overhead (MSOH) which passes through the regenerators in a transparent manner. In particular, in the MSOH section there is a plurality of bytes located at very definite standardized positions and bytes reserved for purposes to be defined and standardized.

[0004] As defined by ITU-T *Recommendation* G.841, the Automatic Protection Switching (briefly, APS) protocol of a telecommunication ring is carried on two special bytes, the so-called K1 and K2 bytes, of the MSOH section. In particular, the same ITU-T *Recommendation* G. 841 provides that, as far as the K1 byte is concerned (see Fig. 3), its first four bits (bits a_{K11}, a_{K12}, a_{K13}, a_{K14}) carry bridge request codes (codes requesting transmitting identical traffic over protection and working channels) whereas the subsequent four bits (bits a_{K15}, a_{K16}, a_{K17}, a_{K18}) carry identifications (IDs) of the destination node for the bridge request code indicated in the first four bits. The function of the byte K2 (see again Fig. 3) is as follows: the first four bits (bits a_{K21}, a_{K22}, a_{K23}, a_{K24}) carry source node identification; bits a_{K26}, a_{K27}, a_{K28}, define the status of the node whereas the fifth bit (a_{K25}) represents a path length code (0 = short path, 1 = long path).

[0005] For example, as far as the 2 fiber, 4 fiber and transoceanic MS-SPRING protections are concerned, the problem of increasing the number of nodes manageable by the protection arises. Since at present the available bits for the IDentification (ID) of the source (a_{K21}, a_{K22}, a_{K23}, a_{K24}) or destination (a_{K15}, a_{K16}, a_{K17}, a_{K18}) nodes are only four, the existing telecommunication rings cannot have more than sixteen nodes. This obviously repres nts a high limitation in the development of communications networks.

[0006] Another problem related to the K1 and K2 bytes is that, when they chang , there is an interrupt from th ASIC to the microproc ssor for ach changed byte (hence one or, at the most, two). In any case it is necessary to manag the temporality of the events to fully manage the information contained in the K1 and K2 bytes.

[0007] In view of the prior art drawbacks, the main object of the present invention is to provide a method of temporally managing, in an optimized manner, the information of the K1 and K2 bytes and therefore increasing the switching rate in a telecommunications ring. A correlated object of the present invention is also to provide a solution for increasing the maximum number of nodes that can be present and managed by the APS protocol, in a communications ring.

[0008] A further object of the present invention is to provide an SDH (or SONET) frame with a proper byte that allows an optimization of the time management of the information of bytes K1 and K2 and allows the management of a ring with a number of nodes higher than sixteen, the highest number which is provided for at the present time.

[0009] These and further objects are achieved by means of a frame having the features set forth in independent claim 1 and a method having the features set forth in claim 7. Further advantageous features of the invention are set forth in the respective dependent claims.

[0010] The invention substantially provides for properly utilizing one byte of the MSOH section of the Section OverHead SOH: some bits of such byte are used as extension of the source node IDentification, some others as extension of the destination node IDentification and finally some others in order to optimize the reception of the change of information carried by the other bytes K1 and K2.

[0011] The invention will certainly result in being clear after reading the following detailed description, given by way of a mere exemplifying and non limiting example, to be read with reference to the appended drawings wherein:

- Fig. 1 schematically shows the function of the various bits of the K0 byte according to a first arrangement in accordance with the present invention;
- Fig. 2 schematically shows the function of the various bits of the K0 byte according to a second and different arrangement in accordance with the present invention; and
- Fig. 3 schematically shows the known and standardized arrangement of the K1 and K2 bytes.

[0012] While the present description and annexed claims mainly refer to SDH transmissions just for clarity reasons, it should be noted that this does not constitute a limitation due to the fact that the present invention clearly equally applies to SONET. Unless otherwise specified, whenever only "SDH" is mentioned, this also includes "SONET". The same is for Recommendations:

while only ITU-T Recommendations are m ntioned, this is just for reducing the d scription length, a man skill d in th art will asily b abl to identify the corresponding equivalent ETSI R commendations.

[0013] Therefore, in accordance with the present invention, one of the "available" bytes, namely a byte whose function has not been defined and/or standardized yet, of the MSOH (to this end reference should be made to the above-cited ITU-T *Recommendation* G. 841) is used. Just for convenience, this being not a limitation, in this description such a byte will be defined as "K0 byte" or "K3 byte".

[0014] With reference to Figures 1 and 2, the K0 byte has bits relating to the source node IDentification, bits relating to the destination node IDentification and at least one bit for optimizing the reception of information carried by bytes K1 and K2.

[0015] The first bit arrangement (Fig. 1) of the K0 byte provides for two Source Node IDentification Extension (IDSNE) bits (bits a_{K05}, a_{K06}); the subsequent two bits (bits a_{K07}, a_{K08}) similarly contain a Destination Node IDentification Extension (IDDNE) whilst the other bits (bits a_{K01}, a_{K02}, a_{K03}, a_{K04}) are used for optimizing the reception of changes of the information carried by bytes K1 and K2. Through this first bit arrangement of the K0 byte, the number of the ring nodes may be up to 64.

[0016] The second bit arrangement (Fig. 2) of the K0 byte provides for three Source Node IDentification Extension (IDSNE) bits (bits a_{K03}, a_{K04}, a_{K05}); the subsequent three bits (a_{K06}, a_{K07}, a_{K08}) similarly contain a Destination Node IDentification Extension (IDDNE) whilst the other bits (bits a_{K01}, a_{K02}) are used for optimizing the reception of changes of the information carried by bytes K1 and K2. Through this second bit arrangement of the K0 byte, the number of the ring nodes may even be up to 128.

[0017] In practice, with the first bit arrangement of the K0 byte, the source node is identified by six bits (the first four bits (bits a_{K21}, a_{K22}, a_{K23}, a_{K24}) of the K2 byte and the two bits (a_{K05}, a_{K06}) of the K0 byte) whereas with the second arrangement the source node is identified by seven bits (the first four bits (a_{K21}, a_{K22}, a_{K23}, a_{K24}) of the K2 byte and the three bits (a_{K03}, a_{K04}, a_{K05}) of the K0 byte). The same applies to the destination node which in one case is identified by the second four bits (bits a_{K15}, a_{K16}, a_{K17}, a_{K18}) of the K1 byte and by the last two bits (bits a_{K07}, a_{K08}) of the K0 byte and, in the other case, again by the second four bits (bits a_{K15}, a_{K16}, a_{K17}, a_{K18}) of the K1 byte and by the last three bits (bits a_{K06}, a_{K07}, a_{K08}) of the K0 byte. In this manner, as said above, the number of nodes may be up to 64 or 128. It is a good thing to point out that the less significant bits are those of bytes K1 and K2 (for the source node, the less significant bit is the a_{K24} bit, whereas for the destination node it is the a_{K18} bit).

[0018] As to the "TOGGLE" bits which are dedicated to th chang of information (bits a_{K01}, a_{K02}, a_{K03}, a_{K04} in the first arrangement of the K0 byt and bits a_{K01}, a_{K02} in the second arrangement) th y change only in the presence of a change of th K1 byt , of th K2 byte or of the bits of the K0 byt . If th K0 byte (with the arrangement of Fig. 1) is conventionally 1100 at the beginning, should a bit of the K1 (or K2) byte change, the K0 byte would become 0011, an interrupt would be generated and both bytes K1 and K2 would be read out. In other words the TOGGLE of the K0 byte must simply say if K1 and/or K2 and/or K0 have changed. Therefore, in principle, one bit only, whose value could be 0 or 1 (e.g. 0 to indicate a change of K1 and/or K2, 1 to indicate no change at all or the contrary) would be enough. It is however evident that the bits reserved for the TOGGLE will generally be even in number (four for the arrangement according to Fig. 1 and two for the arrangement according to Fig. 2). However it is preferred, for higher safety, that the value of all the TOGGLE bits changes going from one condition (no change of K1, K2 or K0) to another (change of K1, K2 or K0). Thus one could have for instance: 0000/1111, 1100/0011, 1010/0101, 1001/0110 (arrangement of Fig. 1) and 11/00, 10/01 (arrangement of Fig. 2).

[0019] In other words, the "overall" or "extended" IDentification of the destination node is computed with the following algorithm:

$$IDDN_{K_1+K_0} = IDDN_{K_1} + 16 * IDDNE_{K_0}$$

[0020] Where: $IDDN_{K1+K0}$ = binary number "extended" IDentification of the Destination Node (calculated by using the bits of K1 and K0); $IDDN_{K1}$ = binary number IDentification of the Destination Node (bits a_{K15}, a_{K16}, a_{K17}, a_{K18}); $IDDNE_{K0}$= binary number Extension of the Destination Node IDentification (bits a_{K07}, a_{K08}; a_{K06}, a_{K07}, a_{K08}). The bit sequence will be one of the following: $a_{K07}\ a_{K08}\ a_{K15}\ a_{K16}\ a_{K17}\ a_{K18}$ or $a_{K06}\ a_{K07}\ a_{K08}\ a_{K15}\ a_{K16}\ a_{K17}\ a_{K18}$
(where a_{K18} is the less significant bit).

[0021] Similarly, the "overall" or "extended" IDentification of the Source Node is calculated with the following algorithm:

$$IDSN_{K_2+K_0} = IDSN_{K_2} + 16 * IDSNE_{K_0}$$

[0022] Where: $IDSN_{K2+K0}$ = binary number "extended" IDentification of the Source Node (calculated by using the bits of K2 and K0); $IDSN_{K2}$ = binary number IDentification of the Source Node (bits a_{K21}, a_{K22}, a_{K23}, a_{K24}); $IDSNE_{K0}$ = binary number Extension of the Source Node IDentification (bits a_{K05}, a_{K06}; a_{K03}-a_{K05}). The bit sequence will be one of the following:
$a_{K05}\ a_{K06}\ a_{K21}\ a_{K22}\ a_{K23}\ a_{K24}$ o $a_{K03}\ a_{K04}\ a_{K05}\ a_{K21}\ a_{K22}\ a_{K23}\ a_{K24}$
(where a_{K24} is the less significant bit).

[0023] Both th algorithms in question can of cours be perform d by a software program running in a com-

put r and therefore th scope of th pr s nt invention extends to such a software program and to a computer memory into which the software program has been loaded.

[0024] In practice, in the solution according to the present invention the K0 byte is partially and primarily used to indicate whether information contained in the K bytes (K1 and K2) or in K0 is changed and has to be analyzed or not. Hence an interrupt is possibly generated only upon receipt of the K0 byte and after the readout thereof.

[0025] The person skilled in the art will acknowledge that it would also be possible to use the first four bits of the K0 byte for the Source Node Extension IDentification (IDSNE) and the subsequent four bits for the Destination Node Extension IDentification (IDDNE): in this way the telecommunications ring could have up to 256 nodes but switching would certainly be slower since in reception the information contained in K1 and in K2 would be read and the interrupts would be activated in reception by the same bytes K1 and K2. In other words, at each node of the ring, K1 is read/written but one has to wait a certain time for K2 and K1. A further possible bit arrangement of the K0 byte could also provide for a sole bit (for instance a_{K01}) as an extension of the source node, only one extension bit (e.g. a_{K02}) of the destination node and one or more of the remaining bits (a_{K03} - a_{K08}) as TOGGLE: the maximum number of manageable nodes however would be only 32.

[0026] As far as the present invention is concerned, in transmission the transmitter must take care of sending first the bytes K1 and K2 and only finally K0 byte: only if the latter contains in the "TOGGLE" field a code which different from the preceding one, it will trigger the interrupt. Only at this point the entire information contained in the three bytes will be read.

[0027] Naturally, the inventive concepts of the present invention are however valid also in the case where the order of the bits is not that indicated in Figs. 1 and 2. In other words, the toggle bits could also be the last four or the last two of K0 (namely, the less significant ones) and not necessarily the first four and the first two. Similarly, the order of the IDSNE and IDDNE bits could be inverted without impairing the generality of the present invention.

[0028] Lastly, as far as the position of the K0 byte is concerned, there are no special constraints except that of using one of the bytes so far not utilized by the SDH (or SONET) frame. Conventionally, for reasons of possible future use of the other bytes, it is preferred that the K0 byte is in the 9th row and 9th column of the first STM-1, in practice the one in the lower right-hand corner.

[0029] It is apparent that numerous modifications can be imparted to the embodiment illustrated and describ d in detail without departing from the scop defined by th following claims which are all intended to b an integral part of th present description.

Claims

1. Telecommunication signal frame comprising a section ov rh ad (SOH) with a Regeneration Section OverHead (RSOH) comprising in turn a first byte (K1) and a second byte (K2), said first byte (K1) comprising bits (a_{K15}, a_{K16}, a_{K17}, a_{K18}) identifying the destination node and said second byte (K2) comprising bits (a_{K21}, a_{K22}, a_{K23}, a_{K24}) identifying the source node, characterized in that said Multiplex Section OverHead (MSOH) comprises a third byte (K0) comprising at least one Source Node IDentification Extension bit (a_{K05}, a_{K06}; a_{K03}, a_{K04}, a_{K05}), at least one Destination Node IDentification Extension bit (a_{K07}, a_{K08}; a_{K06}, a_{K07}, a_{K08}) and at least one bit (a_{K01}, a_{K02}, a_{K03}, a_{K04}; a_{K01}, a_{K02}) indicating a change of the information in said first and/or second and/or third bytes (K1, K2, K0).

2. Frame according to claim 1, characterized in that said Source Node IDentification Extension bits (a_{K05}, a_{K06}) and said Destination Node IDentification Extension bits (a_{K07}, a_{K08}) are two in number and said bits (a_{K01}, a_{K02}, a_{K03}, a_{K04}) indicating an information change are four in number.

3. Frame according to claim 1, characterized in that both said Source Node IDentification Extension bits (a_{K03}, a_{K04}, a_{K05}) and said Destination Node IDentification Extension bits (a_{K06}, a_{K07}, a_{K08}) are three in number and said bits (a_{K01}, a_{K02}), indicating an information change are two in number.

4. Frame according to claim 2, characterized in that said Source Node IDentification Extension bits (a_{K05}, a_{K06}) are the fifth and sixth bits of the third byte (K0), said Destination Node IDentification Extension bits (a_{K07}, a_{K08}) are the subsequent two ones and said bits (a_{K01}, a_{K02}, a_{K03}, a_{K04}) indicating an information change are the first four ones.

5. Frame according to claim 3, characterized in that said Source Node IDentification Extension bits (a_{K03}, a_{K04}, a_{K05},) are the third, fourth and fifth bits of the third byte (K0), said Destination Node IDentification Extension bits (a_{K06}, a_{K07}, a_{K08}) are the subsequent three ones and said bits (a_{K01}, a_{K02}) indicating an information variation are the first two ones.

6. Frame according to any of claims 1 to 5, characterized in that the third byte (K0) is located at the 9th row, 9th column of the first STM-1 of the frame.

7. Method for optimizing th time management of th information carried by a first byte (K1) and a second byt (K2) of th Multiplex Section OverHead (MSOH) of the S ction Overhead (SOH) of a tele-

Byte K0							
TOGGLE: Change of Information				IDSNE: Source Node IDentification Estension		IDDNE: Destination Node IDentification Estension	
bit a_{K01}	bit a_{K02}	bit a_{K03}	bit a_{K04}	bit a_{K05}	bit a_{K06}	bit a_{K07}	bit a_{K08}

Fig. 1

Byte K0							
TOGGLE: Change of Information		IDSNE: Source Node IDentification Estension			IDDNE: Destination Node IDentification Estension		
bit a_{K01}	bit a_{K02}	bit a_{K03}	bit a_{K04}	bit a_{K05}	bit a_{K06}	bit a_{K07}	bit a_{K08}

Fig. 2

Byte K1							
Bridge Request Code				IDDN: Destination Node IDentification			
bit a_{K11}	bit a_{K12}	bit a_{K13}	bit a_{K14}	bit a_{K15}	bit a_{K16}	bit a_{K17}	bit a_{K18}

Byte K2							
IDSN: Source Node IDentification				Path Length	Node Status		
bit a_{K21}	bit a_{K22}	bit a_{K23}	bit a_{K24}	bit a_{K25}	bit a_{K26}	bit a_{K27}	bit a_{K28}

Fig. 3